



Weaver ant (*Oecophylla smaragdina*), huntsman spider (*Heteropoda venatoria*) and house gecko (*Hemidactylus frenatus*) as potential biocontrol agents of the nuisance pest, *Luprops tristis*

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Abstract

Massive seasonal invasion of huge aggregations of rubber litter beetle, *Luprops tristis*, into residential buildings prior to the onset of monsoon rains, and their prolonged stay in a state of dormancy for 8-9 months, is a regular event in rubber plantation tracts. Odoriferous defensive gland secretions released by the beetles are suggested as repelling the potential natural enemies of *Luprops* and a key reason for their unabated massive population build up. In the present study the influence of defensive glands of *Luprops* in determining the feeding preference of the huntsman spider (*Heteropoda venatoria*), weaver ant (*Oecophylla smaragdina*) and house gecko (*Hemidactylus frenatus*) on *Luprops* and the feeding preference of the predators are tested. Results revealed that the tested predators fall under two categories with one group (house geckos and spiders) deterred by the presence of defensive gland and the other group (weaver ants) not deterred by the gland. Higher consumption of *Luprops* by weaver ants establishes that among the three predators tested, weaver ants is the most efficient predator of the *Luprops* and has potential in the biocontrol of *Luprops* in rubber plantations.

Keywords: Rubber litter beetle, Mupli, Biocontrol, Natural enemies.

Introduction

Massive seasonal invasion of huge aggregations of *Luprops tristis* (Fabricius, 1801), into residential buildings prior to the onset of monsoon rains, and their prolonged stay in dormancy for 8-9 months, is a regular event in rubber plantation tracts in South India. Their high abundance in the range of 0.5 to over 4 million per residential building, illustrates the regional importance of *L. tristis* as a nuisance species. Clusters of several hundred to thousands attracted to light crawl inside the living rooms and fall off into beds and food from ceilings making them the most dreaded beetles to farming communities in rubber plantation belts. They do not sting or bite, but when disturbed, they release an irritating odoriferous secretion that burns the skin (Sabu *et al.*, 2008; Sabu and Vinod, 2009). Since the invasion and the nocturnal activities of the beetle takes place during rainy season and lasts for weeks, affected people are left with little choice but to kill the invaded beetles by indoor spraying of insecticides in living rooms. There is no data on the magnitude of environmental pollution it causes or

the health impairment arising from the indoor application of insecticides. Despite three decades of their widespread presence in the region, no efficient strategies for controlling the population build up of *L. tristis* have been developed and there is a critical need to develop environmentally benign control tactics. Identification of natural enemies and their introduction would be a right step in this direction. Search for the natural predators in rubber plantations and residential buildings revealed that huntsman spider (*Heteropoda venatoria*), weaver ant (*Oecophylla smaragdina*) and house gecko (*Hemidactylus frenatus*) occasionally prey upon these beetles. Odoriferous defensive gland secretions released by the beetles are suggested as repelling the predators and could be a key reason for their unabated massive population build up (Abitha *et al.*, 2010). Nevertheless, there have been no empirical observations to confirm that defensive glands deter the natural predators. In the present study, feeding preference of the huntsman spider (*Heteropoda venatoria*), weaver ant (*Oecophylla smaragdina*) and house gecko

(*Hemidactylus frenatus*) on *Luprops* and the influence of defensive glands in determining the feeding preference of the natural predators were evaluated. It is hypothesized that when offered a choice of normal beetles and gland removed beetles (hereafter referred as glandless beetles), predators will show feeding preferences towards glandless beetles.

Materials and Methods

The present investigation was carried out during March, 2009 to May, 2010. The laboratory experiments were conducted at the Dept. of Zoology, Devagiri College campus, Calicut and the studies in residential buildings were conducted in a residential building located at East Hill, Calicut.

Beetles (*Luprops tristis*) were collected from a rubber plantation in the Devagiri college campus by sifting rubber litter. Defensive glands of the beetles were removed by holding the beetles between left thumb and index finger and placing on the stage of stereo zoom microscope with ventral surface of the insect facing up (Vinod *et al.*, 2009). When pressed with modest pressure, the glands were extruded and the extruded glands were cut off using a pair of fine scissor or forceps. The glandless beetles were washed in distilled water and in 10% alcohol to remove the defensive gland secretions and the beetles were blotted dry and transferred to insect cages.

Ten huntsman spiders (*Heteropoda venatoria*) of similar size and undetermined age and sex, were collected live from a residential building with sweep net and were confined to individual cylindrical plastic container (8.5 cm diameter and 15 cm height) topped with mesh net and were starved for seven days. Damp cotton ball was placed in a small dish in the container as source of water. Feeding preferences of spiders were analysed by releasing ten glandless beetles into five cylindrical plastic containers and ten normal beetles into the remaining five cylindrical plastic containers for a 12 hour period starting from 18 hours to 6 hours. After the 12 hour exposure, unfed beetles were collected and numbers were recorded. Spiders were kept unfed for seven days and the same experiment was repeated. Each plastic container comprised one replicate and total of 10 replicates each for glandless and normal beetle was available for data analysis.

Attempts to analyze the feeding preferences of weaver ants (*Oecophylla smaragdina*) and house gecko (*Hemidactylus frenatus*) by rearing in laboratory set up failed as both the predators did not attempt to

feed upon the offered prey. Hence, the feeding preference was analysed by placing beetles close to their foraging area in a residential building. Individual beetles tied to 30 cms long cotton thread and with the free end of the thread glued to the wall of the residential building were placed close to wall mounted lamp shades selected as hiding place by house gecko in residential buildings for a 12 hour period starting from 18 hours to 6 hours. Similarly, beetles tied to a cotton thread were placed on the branches of a mango tree with nesting colonies of weaver ants for a 12 hour period starting from 6 hours to 18 hours. To prevent the possibility of wall lizards feeding on other light attracted insects and entry of other arthropod pests in to the room, windows and ventilators of the room were covered with five mm nylon nets and also by manually clearing the room free of common house hold arthropod pests ten days prior to the initiation of the study. Experiments with house gecko were done using five house geckos spotted in the building and each trial was repeated at five days intervals. During each feeding trial, a set of five beetles (normal and glandless beetles separately) were made available to each predator for a 12 hour period and the number of fed and unfed beetles were recorded.

Distribution of data sets was analysed with Jarquebera test (Weiss, 2007). Predation on different prey items (beetles with gland and without gland for each type of predators (huntsman spider, house gecko and weaver ants) was analyzed as a one-way ANOVA on numbers of prey eaten. Variation in the quantity of prey items consumed by each predator was analysed with one-way ANOVA followed by Tukey-kramer test. All statistical data analyses were performed with MegaStat Version 10.0 (Orris 2005).

Results

Preference of weaver ants, house gecko and huntsman spiders towards normal and glandless beetles: House gecko consumed 3.7 ± 0.95 glandless beetles and 2.6 ± 0.70 beetles with gland, and huntsman spiders consumed 0.9 ± 0.74 glandless beetles and 0.3 ± 0.48 beetles with gland during the 12 hour study period (Fig. 1). Significant variation was recorded in the feeding preference with spider and gecko preferring beetles without glands than those with glands ($p \leq 0.05$). Weaver ants consumed 4.9 ± 0.32 glandless beetles and 4.8 ± 0.42 beetles with gland during the 12 hour study period. No significant variation was recorded in the feeding preference of weaver ants towards beetles with and without defensive glands ($p \geq 0.05$).

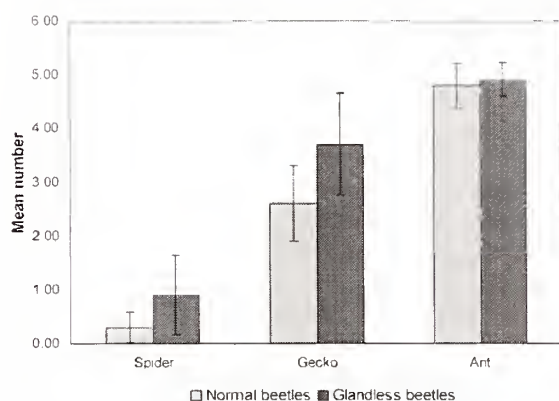


Fig. 1: Bar diagram of the feeding preference of spiders (*Heteropoda venatoria*), weaver ants (*Oecophylla smaragdina*) and wall lizard (*Hemidactylus frenatus*) on *Luprops tristis* with and without defensive glands.

Significant variation in the number of beetles fed by huntsman spider, house gecko and weaver ants was distinct. Pair wise analysis of the feeding preference (spider/gecko; spider/weaver ant; gecko/weaver ant) revealed that among the three predators, weaver ants consumed the highest (4.8 ± 0.42) and spiders consumed the lowest number (0.3 ± 0.48) of beetles during the 12 hour study period ($p \leq 0.05$). Feeding preference of gecko (2.6 ± 0.70) was intermediate between weaver ants and spiders.

Discussion

Higher consumption rate by weaver ants and the non-deterrence by the glands establish clearly that among the three predators tested weaver ants are the most efficient predator of *Luprops* and hence likely to be the most potential biological control agent of *Luprops*. High variation in the quantity of beetles consumed between ants and other predators must be influenced by involvement of many individuals as weaver ants are social insects. Since, among the three predators ants are social insects and the others are solitary feeders, estimating the feeding preference of ants with a single individual was not possible and we took into consideration the number of beetles consumed by a spider, a gecko and the colony of ants during a fixed time duration. Recent research has demonstrated the effectiveness of weaver ants in controlling several pests in mango orchards (Peng and Christian, 2004, 2005, 2006 and 2007), cashew plantations (Peng *et al.*, 1999 and 2005), citrus and sapodilla orchards (Van Mele and Cuc, 2000; Van Mele *et al.*, 2002; Van Mele and Chien,

2004), coconut plantations (Kumaresan, 1996) and cocoa plantations (Way and Khoo, 1989). Although generally regarded as beneficial, the economic value of using weaver ants have been tested with rigorous scientific methods, even then weaver ants are still often regarded as a nuisance pest during harvesting of crops (Sinzogan *et al.*, 2008). Hence, the proposal of introducing weaver ants as a natural enemy is less likely to be welcomed by the planters and rubber tappers in the rubber belts, as their bites and uncontrollable aggressiveness may make rubber tapping a difficult task. We propose that, since rubber tappers do not have to reach the canopy and disturb the nests in rubber plantations and tapping and latex collection is done in the early morning hours when weaver ants are less active, weaver ants may not be a serious threat to rubber tappers. Further disturbance to the tappers from ants can be solved by the use of ash as a deterrent as done in Australian mango and Chinese citrus orchards. Hence, in view of the absence of no other control measures, absence of natural enemies and the alarming rate of population build up of *Luprops* in the rubber belts, reluctance to deploy weaver ants in biological control should be overlooked. Since rubber trees are not widely selected as host plant by weaver ants and ants nest generally on the tree tops the introduction of canopy dwelling ants to the litter floor of the rubber plantations requires introduction of short statured varieties of the preferred host plants of weaver ants that can grow under the shades of rubber plantations and introduction of colonies of ants by bringing ant's queen as practiced in other parts of the world is suggested.

The tested predators fall under two categories with one group deterred by the presence of defensive gland and the other group with not deterred by the glands. Results show that, the defensive gland secretions deters and apparently functions as a protection against house geckos and spiders but not against weaver ants. Absence of variation in the quantity of glanded and glandless beetles fed by weaver ants and the observed biting of weaver ants on the vicinity of defensive glands indicate that defensive gland secretions have no deterring effect on ants. It is likely that the weaver ants themselves who produces a vast array of pheromones (Crozier *et al.*, 2009; Dejean *et al.*, 2005; Beugnon and Dejean, 1992) are insensitive to the gland secretions of *Luprops*. Inactivity and the peculiar behaviour of holding on to objects shown by *Luprops* in response to the arrival of ants, we consider as a defensive action. We propose that since weaver ants produce some of the most persistent ant pheromones and mark their entire

territories and trails with pheromones (Dejean *et al.*, 2005; Beugnon and Dejean, 1992; Dejean and Beugnon, 1991), and these pheromones warn all organisms with a fitness related to the presence of weaver ants (The pheromone avoidance hypothesis, Offenberg, 2007; Offenberg *et al.*, 2004), *Luprops* beetles must be taking a defensive posture in response to the trail pheromones left by the ants in its territory where the experimental animals have been placed.

Conclusions

i). Defensive gland secretions of *Luprops* deterred house gecko (*Hemidactylus frenatus*) and spider (*Heteropoda venatoria*) and not deterred the weaver ants (*Oecophylla smaragdina*).

ii). In an applied biological control context, weaver ants (*Oecophylla smaragdina*) are most likely to be an effective biocontrol against *Luprops* present in rubber plantations.

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